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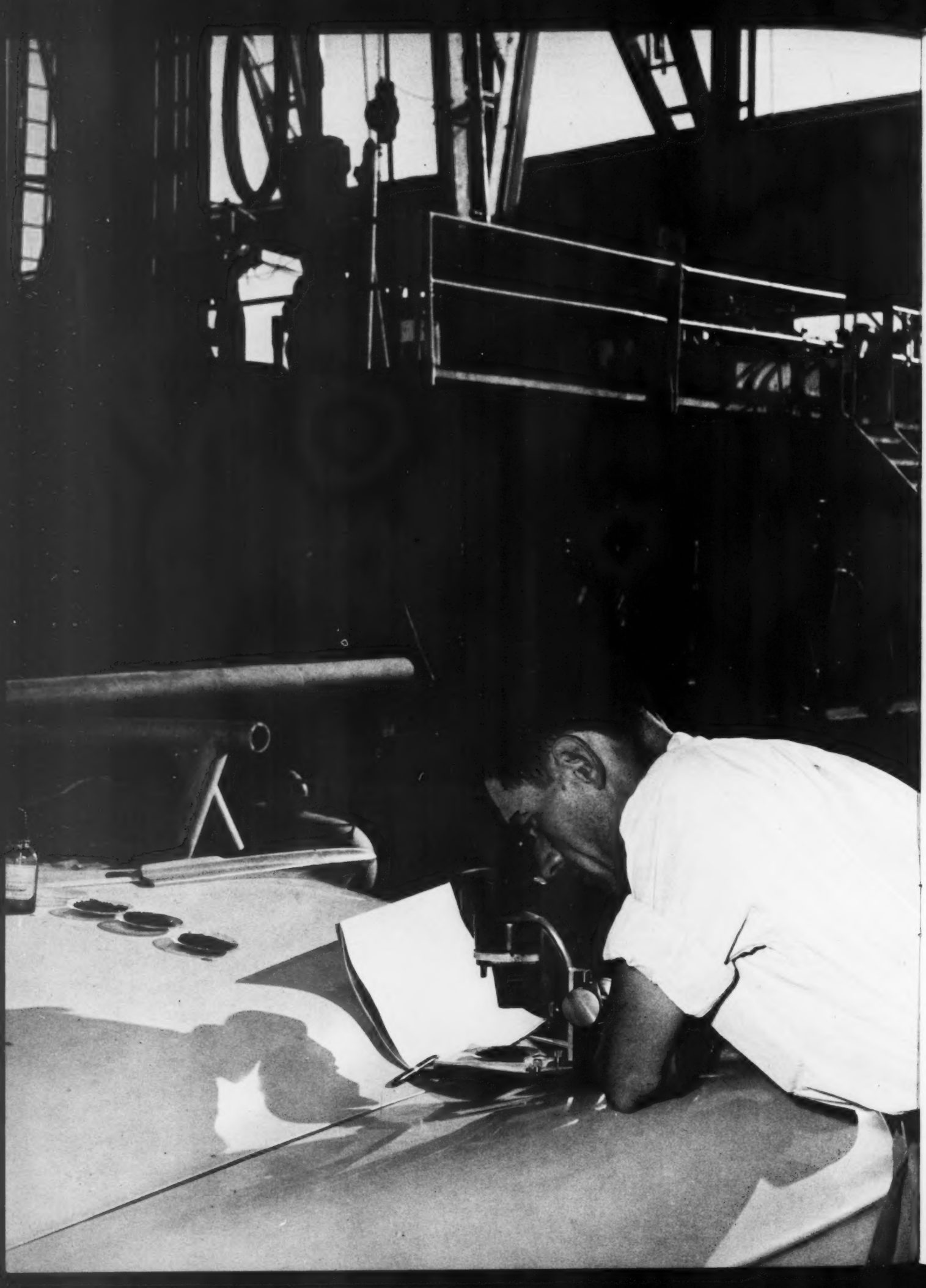
Where LaSalle Landed in Texas

By E. M. Schiwetz

The HUMBLE WAY

SEPTEMBER - OCTOBER, 1953



The HUMBLE WAY
SEPTEMBER-OCTOBER, 1953
Vol. IX No. 3

We Can See Underground

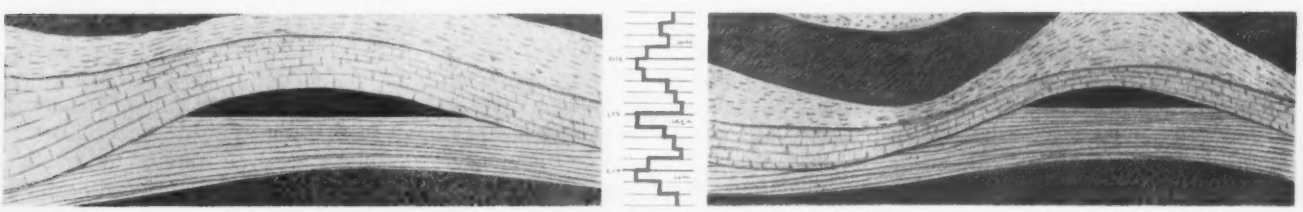
IN SOME legal jousting which took place in a Texas courtroom a few years after Spindletop, an experienced oilman took the witness stand to describe the nature of oil in a reservoir. The reservoir, he said, was like an underground house. It had rooms, closets, halls, and doors.

A lawyer, relating this incident in after years, told how the witness went on to explain the discovery of oil to the court:

"If you drilled down and happened to get into a room that was full of oil, you got a gusher. If you happened to get into a closet where the door was shut, you got a duster. If you hit a hall and oil was there, you would get a well that would last a long time.

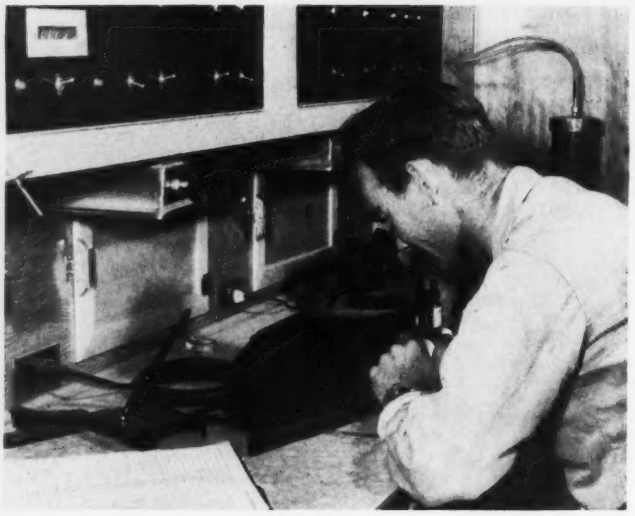
"That sounds foolish to us now," the lawyer added, "but he was as well posted a man as was in the oil business at that time, and there were a lot of queer notions."

Today's oilmen enjoy a great advantage over those pioneer wildcatters. So far-reaching have been the advances in petroleum technology that much of the mystery has been stripped from the dark lairs where oil beds down. In a



Study of cuttings provides geologists with many enlightening facts about subsurface rocks. (See story which begins above.)

Modern driller bases his log on a steady flow of data funneled from below into recording devices on derrick floor.



Mud engineer peers at sample of drilling fluid in hope that fluorescent light will reveal "rainbow" of oil or gas.

very real sense, the modern oilman can "see underground," and more often than not he can tell with uncanny accuracy the types of formations broached by his bit.

The result has been a sharp decline in the prevalence of "queer notions." Reservoir concepts are now firmly based on scientific observations, and geologists have long since abandoned the architectural analogy expounded from the witness stand. Other early ideas, such as the one that oil flows through the earth in restless rivers, have also fallen before the onrush of technology. Today's oil-finding tools and methods provide a picture of the reservoir which often is nearly as clear as if one had a genie riding the bit with a television camera.

Several of these techniques are about as old as the industry: the driller's log, for instance, and the careful examination of mud and cuttings and cores. Pressure gauges and oil well thermometers also qualify as veterans, but some of the other tools are of more recent origin. The electric log, as important to drilling as a map is to treasure hunting, dates back only a little more than 20 years. Newer still are radioactivity logs, the dipmeter, and a variety of other electrical and mechanical gadgets designed for special jobs and special situations.

Geologists and engineers are quick to admit that none of these devices can scan a well bore with panoramic eye and show you everything that lies below. For the picture that comes from nature's darkroom is seldom in the form of a single all-inclusive print. Like an insect whose faceted eye focuses many beams of light into one image, the oilman has to take revealing glimmers from many sources and fit them into a complete picture.

What the oilman winds up with, in short, is a mosaic of underground information. Into this mosaic go such diverse items as tiny bags of cuttings, ribbons of film scored with wavy lines, detailed field and laboratory reports, and subsurface maps. The finished work, while not something you would ever display in an art gallery, may nevertheless be more valuable than a Rembrandt. For hidden therein may be the clue pointing to a successful culmination of one of the world's most risky and expensive ventures—the search for oil.

One of the earliest sources of underground information —and still an important one — was the driller's log. Pioneer drillers knew little about geology, but they soon acquired the knack of recognizing certain formations by, as they put it, "the way the bit acts." A change in the drilling rate, they reasoned, meant a different type of rock had been encountered. While their "calls" were not always on the money, quite often a driller familiar with a certain area could pinpoint with remarkable accuracy the depth of the cap rock and the various layers of rock and shale.

It is to these early logs that we owe the phrases "oil sand" and "gas sand," terms universally used to describe producing formations. The cable-tool drillers studied the rock formations through which they had drilled by means of the cuttings recovered from the bailer and recognized the producing zones as sand. However, if they occasionally found a productive formation which was a limestone or a dolomite, they still labeled it as a "sand" since, to them, the cuttings looked like sand.

Vague as was their nomenclature, these early logs are important even today. In the case of many an old field, they constitute practically all the information we have about the strata underlying individual wells. Not all of them, however, can be trusted. Some of the old-time drillers scorned keeping accurate records, and a few are known to have made their logs from memory after the well was drilled. Most drillers, however, were conscientious about keeping an accurate log insofar as they were able to do so.

The driller's log of today is a much more reliable tool. With a rotary rig, it is possible to keep the main drilling factors constant—the weight on the bit, for instance, and the rotating speed —so that the rate of penetration becomes a good measure of the relative hardness of the rocks being drilled. At

one point, for example, a sharp increase in the drilling rate might indicate that the bit had pierced a reservoir rock and reached a porous and possibly productive formation.

Of course, not every formational change will show up on the driller's log. Hard shale might result in virtually the same drilling rate as sandstone. Then, too, some rock layers are only a few inches thick, and as many as 600 alternating layers of sandstone and shale may be sandwiched together in just one 50-foot section. Generally speaking, though, the driller's log sheds much light on the dark underground and is of great help in correlating and checking, zone by zone, the data obtained from cuttings, cores, electric logs, caliper surveys, and other techniques.

There is an old saying among wildcatters that "the best evidence of oil is oil." In other words, if you can see it or smell it or taste it, then you know for sure that it's there. The most careful study of drilling rates will provide no sensory evidence of this kind. The drilling reports may help to locate a fluid-bearing zone, but you must rely on other methods to tell you whether or not the fluid contained in that zone is a hydrocarbon. One of the most widely used of these methods is mud logging.

In mud logging, a technician at the well site makes continuous tests of the drilling mud as it returns to the surface from the bottom of the hole. If the bit has crunched into a porous formation containing oil or gas, that oil or gas will be entrained in the mud. Very minute quantities of either—ranging down to one part of oil in 100,000 parts of mud—can be detected in the field laboratories which are usually stationed near a drilling well.

The most common test for oil consists of putting the mud sample under an ultraviolet light and looking at it through a microscope. Any oil in the mud will show up as a fluorescent glow. In looking for gas, the technician has recourse to a special instrument which passes the air and any hydrocarbon gases present in the mud over a hot platinum filament. The presence of hydrocarbon gases is indicated by changes in the electrical balance of the filament.

A much older method of seeing underground, but one that is today closely allied to mud logging, is the study of cuttings collected at regular intervals as the well is drilled. The old cable tool driller early began the practice of salvaging rock chips from the bailer, spreading them out on a board, and inspecting them hopefully for signs of oil. If he had reached a productive formation, the driller could quite often detect a film of oil, glowing like a rainbow, on the surface of the damp chips.

When it came to rotary drilling, however, there were problems galore, and for many years no consistent effort was made to collect any study samples of rotary cuttings. For one thing, these cuttings were often reground by the bit or whipped against the side of the hole by the drill pipe and reduced to powder. Even when cuttings reached the surface in fair shape, they were often contaminated by cavings from some upper zone. Another big headache was determining the exact depth from which the cuttings came.

The industry gradually overcame the worst of these problems, and along about 1922 the collection of rotary samples became an established practice. Today, for example, Humble crews take cuttings from the fluid stream at 10-foot intervals. These are carefully sacked and labeled and later submitted to rigorous laboratory tests. Mechanical devices such as a depth indicator and a pump rate meter show at what depth the cuttings originated.

From cores, geologist can extract such tell-tale clues as formation's angle of dip.

Cuttings taken from mud stream undergo careful scrutiny in Company laboratories.

Out of these cuttings are extracted many enlightening clues about the subsurface rocks—facts about the type of formation, its general porosity, and the presence or absence of oil. As in mud logging, ultraviolet light and the microscope play important roles in the hunt for tell-tale oil stains. Also concealed in the cuttings may be tiny fossils which, to an experienced paleontologist, are nature's signposts. Once plotted on a log strip, the many clues from cuttings can be used to corroborate the data obtained by other methods and to correlate the subsurface maps of different wells.

"The development of accurate methods of making sample logs of rotary cuttings," says one writer on geology, "is one of the major achievements of petroleum geology."

Coring, like sample logging, is another time-tested method of seeing what lies below, and for accuracy it rates second to none. (See "The Cores Tell" in The Humble Way, Nov.-Dec., 1946.)

A core is to a drilling well what a plug is to a watermelon — a piece of tangible evidence in cross-section form. It is a long cylinder of the earth's crust,

Electric logging truck lowers into well a device called a *sonde* which passes current into formations. Resistance to current is measured in truck and recorded on film.

ranging up to 100 feet in length, which is cut out by a circular bit and then brought to the surface in a core barrel. Sidewall cores, much shorter and smaller than ordinary cores, are sometimes taken after a formation has been drilled, special coring tools having been devised for this kind of sampling.

The earliest cores were chip cores, large chunks of rock knocked loose by the cable-tool bit and then fished up. The rotary drillers, however, improved on this method. They soon learned that they could take an old stand of pipe, cut teeth in the lower end, rotate the pipe to drill out a core, and then set down weight on the pipe. This bent the teeth under and held the core.

Modern coring devices are a far cry from these crude methods. Some can send up cores on a wire line without any appreciable interruption of the drilling process. And a wide variety of core bits can be called upon. Some of these bits are even diamond-tipped for added cutting power.

Most oilmen would like to core their wells from top to bottom, and it is reported that this has actually been done in a few wells. The only trouble is that the more cores you take, the higher your drilling costs. Usually, therefore, only a few sections are cored. The cores are then sent to a laboratory for analysis, and accurate measurements are made of their porosity, permeability, and oil-water content. With this data, a production geologist is not only able to tell a great deal about a well's prospects, but he can also check the accuracy of his electric and radioactivity logs.

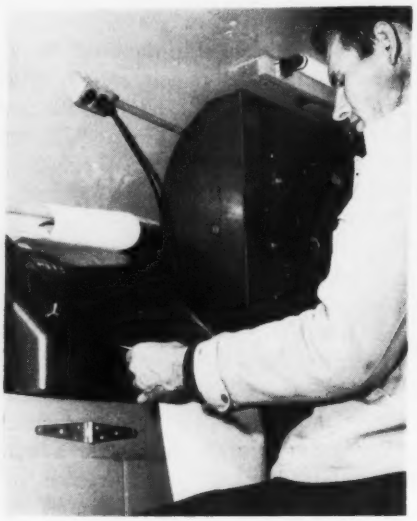
We have already seen that most of the tools used to peer underground serve two main purposes: the location of fluid-bearing zones and the identification of the fluids contained in those zones. In the summer of 1929, at a well site in California's San Joaquin Valley, a new way of doing these things was introduced to the American oil industry. This new seeing-eye tool was originally called "electrical coring," but it is now universally known as the electric log. (See "The Electric Log" in the Nov.-Dec. 1950 Humble Way.)

In making an electric log, a device called a *sonde* is slowly lowered into the uncased hole. Inside the sonde is a system of electrodes through which is sent a steady flow of electricity into the adjacent strata. The resistivity encountered by this electrical current is recorded aboveground on log strips. If a layer of rock contains salt water, it will offer little resistance to the flow of current. But if it contains hydrocarbons, it will show a high resistivity.

The electric log also measures another phenomenon—a natural or self-generated current called the self-potential. An electrochemical reaction is thought to be the main cause of this current, but electrofiltration or electro-osmosis may also be partly responsible. Whatever the source of the self-potential, it serves as a highly useful marker to tell where one rock bed ends and another begins.

What geologists and engineers like to find are formations whose logs show a high resistivity and a strong self-potential. They know that formations with these characteristics are likely to be porous, permeable, and saturated with oil or gas. But that is not always the case. An electric log is, after all, nothing more than a measurement of electrical properties, and there are other factors besides porosity, permeability, and fluid content which can influence those properties.

One of these factors is the conductivity of the drilling mud. If the con-



Operator in logging truck removes film on which is printed "picture" of rock beds.

ductivity of the mud is extremely high, the current from the sonde stays in the mud stream and doesn't get out into the formation. In this case, a latero-log, or guard electrode log, may be used. This is a multi-electrode device that forces a beamed current into the formation and thus reduces the effect of the bore hole fluid.

But suppose, on the other hand, that the conductivity of the mud is extremely low. Here again a special tool is available, this one being called the induction log. It measures the resistivity of formations by means of a magnetic-type device.

The catalogue of logs might be expanded at great length, for the oilman seems to have at hand as many different logging instruments as a surgeon has scalpels.

—The microlog, for instance, has utility in extremely thin formations in addition to being useful as a tool to indicate porous zones.

—Radioactivity logs record the radiation of natural gamma rays to be found in some degree in all rocks, the amount of radiation varying with the different formations.

—Neutron logs serve much the same purpose. One type bombards the formation with neutrons, artificially producing gamma rays which are then measured. Another type measures the neutrons themselves as they bounce back into the instrument.

—The caliper log reveals the diameter of the well bore. Several common operations (setting a packer, sidewall coring, gravel-packing) require that the exact size of the hole be known. In soft formations, however, hole size may be highly irregular as a result of sloughing or erosion caused by the drilling fluid. A caliper instrument with four outstretched arms is pulled up the hole. These arms maintain contact with the sidewall and transmit their measurements by electrical impulses.

—The dipmeter, another electrical instrument, shows the angle of inclination of the sediments penetrated by the well. After a discovery is made, this information may be needed to determine at what depth other wells in the field should be drilled.

—Temperature and pressure surveys also add to our stock of underground information, but they are usually called into play *after* oil is found. An oil well thermometer, by spotting zones of abnormal temperature, can locate with great exactitude a casing leak or the top of a cement plug. A pressure gauge, on the other hand, is a kind of stethoscope used to take the pulse of a well to make sure that its heart is still beating.

Geologist uses strip log to keep tab on the rock beds passed by drilling bit.

Josh Billings, the American humorist, once offered a bit of advice to those who would hunt for oil: "When you strike ile," he said, "stop boring; many a man has bored clean through and let the ile run out of the bottom."

A modern oilman smiles at that idea, just as he does at some of the other old ideas, but he does know that many oil-bearing zones have gone unrecognized in the past. He knows, too, that you can have a prodigious producer in one spot and a dry hole only a hundred feet away. Had Dad Joiner, for example, drilled just a quarter mile to the east of his discovery well, he would have missed—perhaps for good—the great East Texas field.

Today's methods of "seeing underground" are aimed at reducing the number of such oversights and close shaves. This they are doing, and they will probably perform even more useful services in the future.

A former president of the American Association of Petroleum Geologists has said: "If there are ten thousand needles in a haystack, the last thousand will require infinitely more search than the first thousand."

Oilmen aren't sure how many more needles of oil are left underground, but they do know that these needles seem more difficult, and certainly more expensive, to find. They are thankful that they have such a wide range of seeing-eye tools to help them with their task.

Scraps of information from many technical sources are checked and correlated and then fitted together by geologists into formation cross-sections and subsurface maps.

Access road to South Carlton field required half a million yards of dirt fill; is often damaged by river flood waters.

MORE PROBLEMS THAN PROFITS

Finding oil is difficult, but making it pay is often harder

IN A WAY, Humble was pretty lucky to strike oil on the first attempt at South Carlton, Alabama. The oil industry's nationwide drilling records show the odds are about 8 to 1 against that happening. (In South Alabama, where only three oil fields have been discovered, the odds are much less favorable.)

If the good luck had continued, the South Carlton discovery might have turned out to be one of those rare long-shot winners—the one wildcat in 44 that locates a profitable new field.

But the luck didn't hold. Despite every effort to develop and improve the field, South Carlton seems destined to remain a marginal producer. Perhaps it will eventually pay out its actual costs; probably it won't.

To put it bluntly, the South Carlton field is a problem child. That is not unique; the oil industry has many such problem children. They produce just enough oil to justify their continued operation, but they require so much attention and pose so many problems that they sometimes seem hardly worth the trouble they cause. Most people know little about these fields, for the oil industry, like any parent, is reluctant to talk in public about its problem children.

Perhaps the story of the South Carlton field will help bring about a better understanding of these "successful failures."

The South Carlton field is located in an isolated and almost inaccessible lowland about 40 miles north of Mobile Bay. It straddles the great Alabama river only a few miles from the point where that stream joins the Tombigee to form the Mobile river. For miles around, the area is a heavily-wooded semi-swamp, covered at frequent intervals by flood waters from the two rivers. Here and there dim wagon trails wind through the forest. Logging crews use these trails in dry seasons, when they go in to cut timbers that can later be floated out on the flood waters.

Although most of the area is inhabited only by wildlife, there are two small groups of dwellings near the river banks. The unpainted houses and outbuildings are perched high on stilts to keep them above the high water mark. Beside the dwellings are small clearings where the residents cultivate garden crops between floods. Until Humble built a road into the area, these people had only the river to connect them to the outside world.

Humble's interest in this isolated location began in 1941, when a gravity meter crew worked its way down the logging trails and took some readings. From this and subsequent preliminary exploration it was determined that a possible underground structure existed beneath the forest. It seemed worthy of further investigation.

To get more specific information, the Company dispatched a core drilling unit to the area. But the idea of core drilling had to be quickly abandoned. The trucks were unable to negotiate the primitive logging trails, and there was no other way to penetrate the woods.

The next attempt to explore the area was more successful. A seismograph crew, after waiting for the dry season, managed to inch its way through the forest trails and carry out its assigned task.

The picture that could now be pieced together from the information provided by gravity meter and seismograph was an enticing one. A likely-looking structure was located and possible producing horizons were believed to be a little more than 5,000 feet below the surface of the ground. It was a structure that might contain a great reservoir of oil.

But, on the other hand, it might just as well contain no oil at all. Only the drill could tell.

First, however, the land must be leased. Humble's land and lease men had months of hard work before them. They made countless trips up the rivers in small boats, trudged weary miles

through the soggy forests, spent many hours patiently tracing heirs and talking lease terms. There were also surveying problems for the civil engineers, errors in property lines to be worked out, legal problems for the lawyers to solve.

At last, the leases were in order and Humble was ready to proceed with a wildcat test.

Since there were no roads to the site, all drilling equipment, supplies, and personnel had to be transported up the river. To simplify matters, a marine operating base was established on the edge of a backwater lake, with access to a railroad and highway. From this base it was about a 12-mile boat ride to the drilling site at South Carlton.

IN THE first echelon of this tedious operation, earth-moving machines were barged in to build a high embankment upon which to set up the derrick and drilling equipment. This man-made hill had to be taller than the highest water mark shown on the surrounding trees; it would become an island during every flood stage.

When the site had been made ready, a jack-knife drilling rig was barged in and set up. The test was spudded in and was drilled to the desired depth without undue incident. Unless, of course, you count the times the operating crews became lost in the heavy fogs while en route from the marine base to the drilling site and had to spend the night on the boat tied up to the river bank.

The first test well, known as the J. H. Wall Estate et al No. 1, was completed as an oil producer in May, 1950.

It was oil, all right, but it barely qualified for that name. Thick with asphalt, this crude had about the same consistency as black strap molasses. If you poured it out on the ground on a cold day, the stuff would pile up in a heap instead of running off like any respectable liquid is supposed to do. It wouldn't even flow from well to tank battery without the aid of a booster pump.

And there was no gas trapped with this heavy oil to help push it to the surface. Nature must have been in a capricious mood when she planted this reservoir of oil beneath this swampy forest. The oil was there for the taking, but you had to take it. Nature wasn't going to help. The well didn't even produce enough gas to operate a pumping engine. In order to pump the oil out of the ground, you had to haul in the fuel to operate your pump.

This South Carlton well was drilled to depth of 16,000 feet in vain effort to find more favorable producing zones; had to be plugged back to original discovery zone.

But to oilmen searching in an unproven area, any discovery of oil—even crude such as this—is encouraging. Perhaps another well will tap a more favorable producing zone and yield a better grade of oil. Maybe there is a vast reservoir of high grade oil down there, and this asphalty crude is only a marginal pocket.

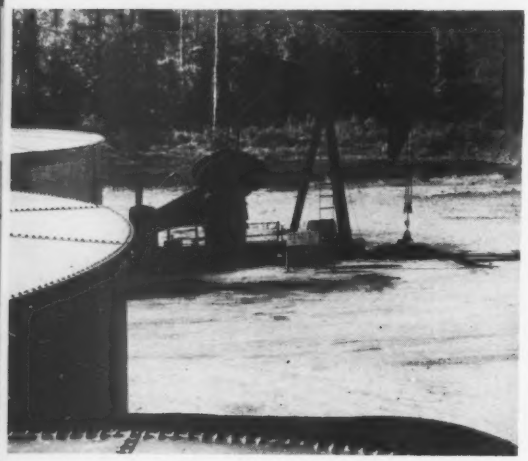
Naturally, Humble tried again. More earth was dragged up to extend the high water embankment to a new drilling site. The derrick and equipment

Special barge, equipped with steam coils to permit reheating of crude at discharge point, takes on heated oil at South Carlton; another loading point is across river.

Radio is only means of quick communication from this isolated oil field.

Crude must be heated to make it flow from tanks to the barge loading point.

Discovery well, and nine other producers in field, depend on diesel pumps.



were hauled over the narrow roadway atop the embankment and set up in the new location. The new well was completed as a producer. But it was no better than the discovery well.

Again and again during the ensuing months Humble moved to new sites and drilled new wells. Some were drilled to deeper levels—one to 16,000 feet—in hope that better producing formations might lie below the discovery depth. It was a vain hope.

After a total of 15 wells had been drilled, the score stood at five dry holes and ten oil producers. There still was not a smidgeon of gas in the field. All the oil was the same molasses-like crude found in the discovery well. By hard pumping, all ten of the producing wells could produce a total of about 350 barrels of oil a day. It was such a strain on the pumps that they required much attention and frequent overhauling.

Meantime, while the drilling program was still in progress, the need for an access road had become more and more apparent. River transportation, at best, was a slow, expensive and inefficient means of serving the needs of an oil field. Finally, the Company's civil engineers laid out a service road eight miles long, connecting the South Carlton field to a county road. This provided access to the town of Jackson, some 25 miles to the north, where there was a paved highway and railroad.

BUT to build and maintain the eight miles of Company road was not a simple matter. The route runs through the lowlands between the two rivers. To keep the roadway above the high water level, Humble's contractors had to build fills containing half a million yards of dirt. In flood seasons the river waters pour in from both sides to claw angrily at this man-made obstruction. There is always the threat that the flood waters will wash out some of the high fills, cut through the road bed, and leave the South Carlton field again isolated from all land transportation.

With ten oil wells producing a most difficult type of crude, Humble had still another tough problem to solve at South Carlton. How could the oil be moved out of this remote spot to a refinery? Somehow it must be transported to Mobile Bay, where it could be taken aboard a tanker. Overland hauling in tank trucks was out of the question because the access road could not bear the heavy traffic. A pipeline was not feasible because the heavy crude would not flow through a line without constant heating. To build and operate a pipeline with sufficient heating facilities would cost more than the value of the oil.

THE only practical solution to the problem was to use the river. Three barge loading points were established on the river banks at South Carlton to handle the oil produced from all wells. The heavy oil has to be heated to get it thin enough to flow the few yards from the storage tanks to the barges. This is done by circulating hot water through pipe coils installed in the tanks.

Even the barges themselves had to be specially built for this job. Inside each barge is a system of steam coils to permit reheating the crude at the unloading point in Mobile Bay. Without heat, the oil won't flow.

The story of the South Carlton field proves that the search for oil is often like chasing the will-o'-the-wisp. Favorable signs beckon the explorer, leading him on step by step until there is no turning back. The ghosts of Spindletop, of East Texas, and other famous big strikes are always looking over his shoulder, spurring him on with vague promises of success. If the explorer hesitates when he finds a dry hole or a disappointing asphalt crude, the ghosts remind him that most major oil discoveries have been made in the face of disappointment or apparent failure.

South Carlton might easily have been an important oil discovery. The right kind of structure was there—a structure large enough, if it had been full, to contain a hundred million barrels of oil. And there was oil in the structure. It just wasn't a good type of oil, and there wasn't enough of it. At no time—from the earliest geophysical exploration to the completion of the final well—was it possible for anybody to say with certainty that this would not become a large and profitable producing oil field. Everything possible was done to make it so. Unfortunately, South Carlton couldn't make the grade.

It is disappointing, but not very surprising. After all, the records of the oil industry show that the odds against finding a *major* oil field with an initial wildcat test are 991 to 1.

La Salle's Landing Near Indianola — *by E. M. Schiwetz*

La Salle sailed far off course, and a random landfall gave Texas its sixth flag. Tragedy stalked his efforts here, but even in defeat his great courage made him

The Magnificent Failure

HE WAS a strange man, this native of Rouen. Born of wealthy (though not ennobled) parents, he had a good education in arts and sciences and in the Church. One who knew him called him a man "of a large soul . . . designing, bold, undaunted . . . not to be discouraged at anything . . . steady in adversity."

But the strong man had grievous faults. To offset his excellent qualities, his behavior could be intolerably haughty, his will too unbending, and his discipline so rigid that it "drew on him an implacable hatred . . ."

From an early age, the interests of this scholar-adventurer lay in the New World. While others measured its resources in terms of gold and gain, he yearned to expand it for the glory of France. For him, far horizons held more lure than the glint of gold. His was the restless spirit, the inquisitive urge to explore strange lands and uncharted seas.

Such was the character of Rene Robert Cavelier, Sieur de La Salle — a man who tossed aside a life of wealth and ease for the discomforts of an existence among savages. One who preferred painted Indians to powdered courtiers, his destiny took him thrice from his native France to the New World. And at the end of his third journey, hiding among tall reeds on a wild Texas plain, lay mutinous men with murder in their hearts.

La Salle had high hopes for the third voyage, which began from La Rochelle on July 24, 1684. Some years earlier, he had journeyed to the mouth of the Mississippi. There he had planted the *fleur-de-lis* flag and claimed the land for France,

Indians Sighted Near Galveston *by E. M. Schiwetz*

naming it Louisiana in honor of his sovereign, Louis XIV.

Reasoning that whoever controlled the Mississippi could control the continent, La Salle sailed now for the mouth of that great river. He proposed, according to one account, to (1) establish a fortified post on the Gulf of Mexico within one year after his arrival there and (2) to fortify on the Mississippi, about 50 leagues above its mouth and organize an expedition against the Spaniards in northern Mexico.

With him on this most enterprising of all his ventures went the *Joly,* a French warship of 36 guns; the bark *La Belle,* a small vessel of six guns; the supply ship *Aimable,* laden with goods to make the settlement; and the ketch *St. Francis,* carrying ammunition and some merchandise bound for Santo Domingo.

LOUIS XIV, described as a man of foxlike cunning, had driven a hard bargain with La Salle. The King agreed to provide soldiers and supplies, but La Salle was bound to refund the cost of the enterprise if it failed after three years.

Some 30 volunteers joined the expedition at La Rochelle, many of them gentlemen eager for adventure and the thrill of the unknown. For colonists came several families, as well as "girls matrimonially inclined." Accompanying La Salle were two nephews and his brother, Abbe Jean Baptiste Cavelier, founder of the order of the Christian Brothers and later canonized by the Church. With him, too, was a "trusted subordinate," one Henri Joutel, who wrote a complete chronicle of the expedition.[1] A number of clerics, mechanics, and workmen joined the adventurous band before it sailed.

MISFORTUNE befell almost before the voyage was well under way. Some 50 leagues out of La Rochelle, the *Joly's* bowsprit shattered, and all vessels turned into Rochefort for repairs. Some thought it no accident, but a piece of deviltry contrived by the ship's jealous and rebellious captain, Beaujeu, a man bitterly vocal in his resentment of La Salle's authority. The Crown had sown seeds of discontent and mutiny when it decreed that Beaujeu would be in command "in what concerns maneuvers," while La Salle "is to determine the route." Other campaigns have failed on less serious divisions of command.

With damage repaired and the voyage resumed, other vexations tightened relationships between the two commanders. Beaujeu muttered of the discomfort of "being on an overcrowded ship with an ill-tempered man." As for La Salle's ability as an explorer, Beaujeu boasted contemptuously that he would know as much as anyone about the country where they landed "at the end of a month." When he proposed to La Salle that the fleet put in at Madeira for water, and was

[1] Joutel's *Journal of La Salle's Last Voyage* provided the basis for this article.

refused, he stormed off to sulk and plot new frustrations for his tormentor. A short time later, he took small vengeance by outstripping the other ships and landing on the opposite side of Santo Domingo from the port agreed upon.

Here, fresh trouble waited. Sickness struck, and a large number of men had to be carried ashore. La Salle himself fell victim of the malady, lapsing into delirium and then into unconsciousness. His brother, the faithful Abbe Jean, nursed him back to health, but in the long period of illness Beaujeu worked overtime at the job of spreading distrust and ill will toward the ailing commander.

NOW came new and serious disaster. Hardly had La Salle recovered from his illness than he was driven into a relapse by news that the *St. Francis,* with its precious load of goods and ammunition, had been captured by the Spaniards. It was a cruel blow, and a council of pilots was called to determine how to proceed. They agreed to steer for the western point of Cuba.

After sighting Cuba and going ashore briefly on the Isle of Pines, where La Salle shot an alligator, the three ships sailed at last into the Gulf of Mexico. They badly overshot their mark. Whether through bad luck or because La Salle had only the latitude of the place he sought and not its longitude, the fleet sailed at least 400 miles too far southwest of the Mississippi's mouth.

Early in 1685, when the ships came upon an island (thought by some to be Galveston), Joutel wrote in his *Journal:*

> "We were very near the Shoar, when we discover'd a number of naked Men marching along the Banks . . . Monseiur de la Sale was very well pleas'd to see them, imagining they might give him some Account of the River he sought after; but to no Purpose . . . they knew nothing of what he ask'd. . . ."

Weighing anchor, the little fleet sailed on.

By now, La Salle must have been uneasy. His men grew restive, food and water were short, and he realized a landing must be made soon, to maintain morale and replenish supplies.

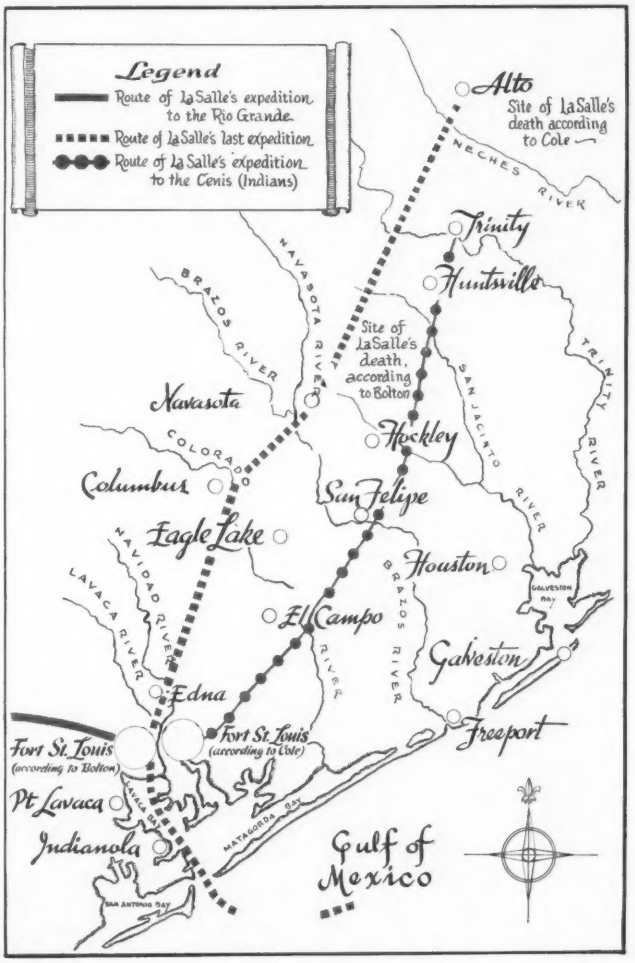
Seeking a place to land, they came at length to what is now identified as Pass Cavallo, an opening between Matagorda Island and Matagorda Peninsula. A scouting party, including La Salle himself, went ashore, found fresh water, and "kill'd a good Store of Ducks, Bustards[2] and Teal, and the next Day two Goats. . . ."

By the middle of February, after a siege of foul weather and more exploration ashore, La Salle resolved to establish a temporary settlement.[3] He gave orders to bring the ships through the pass into the bay. Thus was set the stage for the next in an already grim succession of disasters.

Sounds were taken to determine the depth, stakes were set to indicate a course to steer through the pass, and the captains were ordered to proceed cautiously under short sail at high tide. Whether through bad seamanship or deliberate malice, the captain of the *Aimable* spread full sail and charged through the pass, running his ship aground. High winds and waves later split the helpless craft, scattering her cargo far and wide, most of it floating out to sea. La Salle took the crushing loss with fortitude, as Joutel explains:

> "This Misfortune was so much greater, because that Vessel contain'd almost all the Ammunition, Utensils, Tools and other Necessaries for Monsr. de la Sale's Enterprise and Settlement. He had need of all his Resolution to bear up against it; but his Intrepidity did not forsake him, and he apply'd himself, without grieving, to Remedy what might be."

Here was a grievous state of affairs. With his ketch captured by the Spaniards, with Beaujeu sullen and uncooperative, and with his supply ship beaten to shreds on a sandbar, even the stout-hearted La Salle was discouraged. But he bore



up as best he might, salvaged what he could, and the little camp rapidly took shape on the point of land. Boards washed ashore and brought ashore from the wrecked *Aimable* were used to build rude shelters.

While the settlement was being made, Beaujeu hatched a final piece of revenge. Hoisting sail on the *Joly,* he sped through Pass Cavallo, leaving La Salle under the impression he would return. Instead, he headed straight for France and was heard from no more. The party was thus left abandoned with only the bark *La Belle.*

[2] Cranes or brants.

[3] Historians generally place this as the point of land near the later site of Old Indianola.

Canoes were needed, and La Salle sent a small party to an Indian village to barter for some. While there, his men found that the savages had come upon some bales of Normandy blankets from the wreck of the *Aimable*. La Salle dispatched a party under Ensign du Hamel to bargain for the blankets, instructing the young officer to take them by honest and peaceful means. Instead, du Hamel frightened the Indians away and made off with the blankets, which the savages took as an act of war. That same night, camped along the shore, their fires blazing brightly, the party of Frenchmen was surprised by a volley of arrows which killed two gentlemen and gravely wounded others. One of La Salle's nephews, himself bearing three wounds, carried the alarm to the settlement.

CONCERNED by this sinister turn of events, La Salle resolved to build a fort, using "many pieces of Timber the Sea threw up." Afflictions followed fast, with malcontents and a weak-hearted few deserting the settlement. Joutel noted that:

> "A Spaniard and a French Man stole away and fled, and were never more heard of. Four or five others follow'd their Example, but Monsieur de la Sale having timely notice, sent after them, and they were brought back. One of them was condemn'd to death, and the others to serve the King ten years in that Country."

Meanwhile, with the fort well advanced, La Salle began a program of ceaseless exploration. Still believing the Mississippi might not be far away, he made numerous journeys in search of it, scouting the surrounding country. During one if his absences, those remaining at the fort sighted a Spanish vessel, no doubt dispatched that way in search of the interlopers. Luckily for the garrison, the ship passed on without sighting the settlement.

PARTLY in the interest of better concealment from coasting Spaniards, and partly because a more favorable location was needed, La Salle decided to move his settlement and fort farther inland. A footnote at this point in Joutel's *Journal* locates the second fort on the Lavaca River, called by Joutel *le Riviere aux Boeufs* (River of Bullocks) for the great herds of buffalo that roamed along it. Dr. Herbert E. Bolton, however, holds that the place was "on the west bank of the Garcitas River, about five miles above its mouth, and on the highest point of the cliff-like bank of that stream." The Garcitas and Lavaca Rivers are in the same general area, and Joutel describes the location as follows:

> "We were in about the 27th degree of North latitude, two Leagues up the Country, near the Bay of St. Lewis[4] and the Bank of the River *aux Boeufs*, on a little Hillock, whence we discover'd vast and beautiful Plains, extending very far to the Westward, all level and full of Greens, which afford Pasture to an infinite Number of Beeves and other Creatures."

All the while, La Salle continued to explore, ever hopeful that the Mississippi might be near. In his optimist's mind, every stream he found gave promise of being a tributary of the Father of Waters. But a sense of futility was spreading

[4] Matagorda Bay.

La Salle Monument at Navasota *by E. M. Schiwetz*

Death of La Salle *by E. M. Schiwetz*

among his men. Even the faithful Joutel, who by now spoke of the Mississippi as "the fatal River," blamed it for all their woes.

IN MAY, 1686, misfortune struck again. The *La Belle* ran aground and was lost, leaving the settlement only canoes and rafts. La Salle returned late that year from his longest journey thus far, still without having found his "fatal River" and with only eight of the 20 men who had set out with him. Undaunted, he prepared at once to leave again . . . on the journey that was to be his last. Joutel wrote:

> "We set out on the 12th of January, in the Year 1687 . . . Monsieur de la Sale, Monsieur Cavelier, the Priest, his Brother, Father Anastasius, the Recolet, Messieurs Moranget and Cavelier, Nephews to Monsieur de la Sale, the Sieurs Duhaut, the Elder, l'Arcleveque,[5] Hiens, Liotot, Surgeon, young Talon, an Indian, and a Footman belonging to Monsieur de la Sale."

In some of the latter persons named, La Salle had made some fateful choices.

The first day's stop was at a place the Frenchmen called *le Boucon,* not far from the fort, so named because they had often "dry'd Flesh" there. Meat so dried was called *Boucaner,* from the Indian word. (Pirates took the name of *buccaneers* because they relied to a great extent on boucaner for food.)

The third day out, the little party came upon a lone Indian, who fled for his life but was captured. Most of the men resolved to kill the poor savage, but La Salle would not have it. He treated the fellow kindly, gave him food and tobacco, and sent him on his way. It was a gesture that paid off handsomely in good relations later. Soon after, when a large party of Indians drew near, the savages and La Salle's party met in peace, both sides laying down their arms, then "smoaking and eating" on friendly terms.

ON THE party proceeded, crossing several rivers, among them the Colorado, at a place designated by some historians to have been near the site of modern Columbus, Texas. Joutel tells of other meetings with Indians along the way, and of a visit to a tribal village, where the elders received them well and gifts were exchanged.

Toward the middle of March, Moranget was guilty of an error in judgment that brought on his own death and may have touched off a smouldering conspiracy to kill his uncle.

[5] Should be Larcheveque.

Two buffalo had been killed and the flesh smoked. Liotot, Hiens, Duhaut and others had laid aside the marrow bones "to roast them, and eat the flesh that remained on them, as was usual to do." Moranget denied them this privilege, inflaming them to bloody revenge. Since the party had split before this incident, with La Salle and others going on ahead, the way was clear for the conspirators to carry out their plot.

That night, Liotot took an axe while some of the others stood guard and gave the sleeping Moranget, one of La Salle's nephews, "Many Strokes on the Head. . . ." La Salle's footman and Indian were also hacked to death. According to Joutel, who was told later of the triple murder:

> "The Indian and the Footman never stir'd, but the Sieur Moranget had so much Vigour as to sit up, but without being able to speak one Word, and the Assassins obliged the Sieur de Marle to make an End of him, tho' he was not in the Conspiracy."

With murder already done to his nephew and servants, La Salle's fate was sealed. To save their own skins, the mutineers had to kill their commander. Meanwhile, La Salle had grown uneasy at not having word from the group behind. On the 20th of March, he left Joutel in command of the forward party and went back to find the others. He went back to his death. Joutel tells the story as related to him by Father Anastasius Douay, who accompanied La Salle and saw him murdered:

> "Duhaut passed the River, with Larcheveque. The first of them spying Monsieur de la Sale at a Distance, as he was coming towards them, advanc'd and hid himself among the high Weeds, to wait his passing by, so that Monsieur de la Sale suspected nothing . . . saw the aforesaid Larcheveque at a good Distance from him, and immediately ask'd for his Nephew Moranget, to which Larcheveque answer'd, That he was along the River. At the same Time the Traitor Duhaut fired his Piece and shot Monsr. de la Sale thro' the Head, so that he dropp'd down dead on the Spot, without speaking one Word."

FATHER Anastasius stood frozen with fear, expecting the same fate, but the assassins "put him out of that Dread, bidding him not to fear, for no Hurt was intended him. . . ." Then they stripped La Salle's body and dragged it among the bushes, where they left it for beasts to devour. A later statement by Douay declares that the body was buried and a cross set up on the grave. This may be doubted. Francis Parkman, a noted historian of the La Salle epic, observes that Douay did not "always write honestly," and that he probably invented the story of the burial to cover his own dereliction in having failed to discharge that duty. The site of the assassination is believed by many to have been near the present town of Navasota, Texas, where a statue is erected to La Salle's memory. E. W. Cole, who made an exhaustive study of La Salle in Texas, places the assassination site farther to the northeast, in Cherokee County.

With La Salle dead, Duhaut assumed command. Those who had taken no part in the conspiracy feared for their lives—all but La Salle's brother, the Abbe Jean. According to Joutel, the Abbe:

> ". . . could not forbear telling them, that if they would do the same by him, he would forgive them his Murder, and only desir'd them to give him a Quarter of an Hour to prepare himself: They answer'd, They had Nothing to say to him; that what they had done was the Effect of Despair, to be reveng'd for the ill Usage they had receiv'd."

THE justice due such men came, in their turn, to each of the conspirators. Duhaut was the first to go, being killed by Hiens in an argument over a division of tools. Ruter, who was with Hiens, killed Liotot in the same argument, shooting the surgeon through "with three Balls."

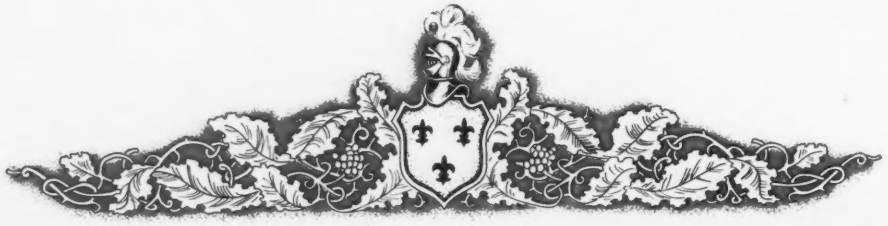
Some time later, after living together in mistrust and fear, the survivors split up. Seven whose hands were clean proceeded toward Canada, among them Joutel and La Salle's brother. The murderers, knowing what fate awaited them the minute they set foot on French soil, remained with the Indians in Texas.

Joutel and the Abbe, after many adventures and great hardship, finally reached Canada, arriving at Montreal in August, 1688. As for the traitors who stayed in Texas, a footnote to Joutel's *Journal* declares:

> "Never were mutiny, conspiracy and assassination more signally and justly followed by retribution than in the fate of these miscreants. . . . Exiled, by their own deeds, from Canada; in fear of their Spanish neighbors, whose dominion they had invaded, they were finally overwhelmed by an Indian attack, many of them butchered and the fort laid waste. Compulsory domestication among their savage captors was the fate of the rest; and when, in 1689, the Spanish general Alonzo de Leon visited the ruined fort of St. Louis in Texas, they were handed over to him, and expiated their sins in the naval service or prisons of Spain."

Thus ended the third and last voyage of La Salle, patriot and explorer. Though the enterprise ended in failure and death for him, it strengthened France's claim to a greater part of the New World.

Curiously enough, the three-year agreement between La Salle and Louis XIV was paid in full. La Salle paid for the venture — with his life — three years after the agreement was made. Though he seemed to fail, it was failure on a magnificent scale.



Joutel's Notes on Texas

Buffalo Herds on the Lavaca River

"We call'd it *le Riviere aux Boeufs,* that is the River of Bullocks, by reason of the great Number of them there was about it. These Bullocks are very like ours, there are Thousands of them, but instead of Hair they have a very long curl'd Sort of Wool."

Indians

"Six or seven of those Savages went along with us . . . We observ'd, that their *Yea* consisted in a Cry, fetch'd from the Bottom of the Throat, not unlike the Call of a Hen to gather her Chickens . . . (they) came and imbraced us in a very particular Manner, blowing upon our Ears . . ."

Catfish

"As for Fish, we had several Sorts in the River and in the Lakes I have mention'd. The River afforded a Sort of Barbles, differing from ours in Roundness, in their having three Bones sticking out, one on the Back, the others on each Side of the Head, and in the Flesh, which is like Cod, and without Scales."

Rattle-Snakes

"Among the venomous Sorts of Snakes, as Vipers, Asps and others, whereof there are many, those call'd Rattle-Snakes are the most common. They generally lye among the Brambles, where they make a Noise by the the Motion of two Scales they have at the End of their Tail, which is heard at a considerable Distance, and therefore they are call'd Rattle-Snakes."*

* At least one member of the expedition died of snakebite. Joutel records the story of M. le Gros, who was bitten while hunting fowl. "The Serpent bit him a little above the Ankle, he was carefully dress'd and look'd after, yet after having endur'd very much, he dy'd at last . . ."

Prickly Pear

"There are others of the Sort I had seen in the Islands, whose Leaves are like Rackets, whence the Tree bears the Name. The Blossoms grow out about the Leaves, and of them comes a Fruit somewhat resembling Figs, but the Leaves and the Fruit are full of Prickles, which must be carefully rubb'd and taken off, before it is eaten, else they dangerously inflame the Mouth and Throat, and may prove mortal, as happen'd to one of our Soldiers, who had eaten of them too greedily, and without that Precaution.

Wild Grapes

"There are Abundance of creeping Vines and others, that run up the Bodies and to the Tops of Trees, which bear plenty of Grapes, fleshy and sharp, not to compare to the Delicacy of ours in *Europe;* but we made Verjuice of them which was very good in Sauce."

Pelicans

"We had . . . many other Sorts of Fowl fit to eat, and among them one call'd *le grand Gosier,* or, the great Gullet, because it has a very large one . . ."

Alligators

"There are also many Alligators in the Rivers, some of them of a frightful Magnitude and Bulk. I kill'd one that was between four and five Foot about, and twenty Foot in Length, on which our Swine feasted. This Creature has very short Legs, insomuch that it rather drags along than walks, and it is easy to follow the Tract of it, either among the Weeds or on the Sands, where it has been . . . I have shot many of them dead."*

* Joutel tells of one occasion of a man being dragged down and devoured by an alligator while a small scouting party was crossing a stream.

TONS OF PREVENTION

Metallurgists at Baytown Refinery cooperate with other groups to keep units working economically

BAYTOWN'S metallurgists and metal inspectors may well scorn the old saying about an ounce of prevention. They measure prevention by the ton. It is far better, they tell you, to *prevent* failure in plant equipment than to hold postmortems over a piece that failed.

It is not enough, in the opinion of these metal specialists, to build refinery equipment without weak spots. They prescribe that each piece be designed with adequate safety factors in accordance with accepted practices. Even with that margin for safety, metallurgists and inspectors go one step farther and check each piece of equipment regularly and recommend the necessary maintenance and repairs or replacement before it collapses like the "wonderful one-hoss shay."

Metals, these specialists know, are a lot like people. You have to understand them, know their strong points and weaknesses, before you can work well with them. Like people, metals have to be assigned the kind of work they can do best. Like people, metals crack under burdens too heavy for them. Some can stand more heat than others; some more pressure, more shock, or more stress. Some tire quickly; others stand up stalwartly after months and even years of heavy pounding, with no signs of fatigue. Acids, caustics, and other chemicals attack some metals more viciously than others—just as the mental corrosion of anxiety and fear afflicts some people more deeply than others.

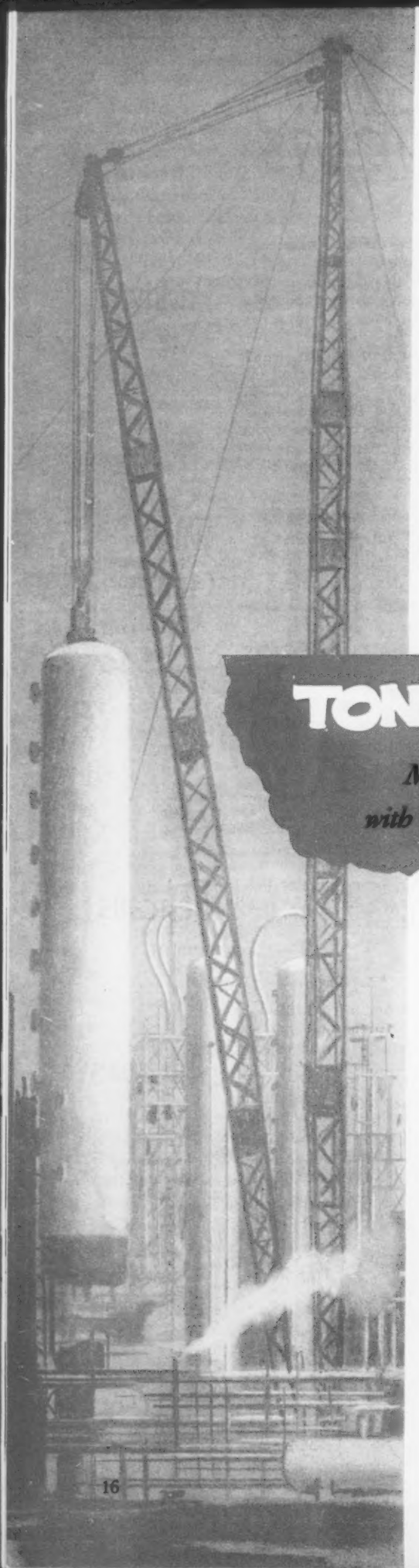
Metals, in short, have their own personalities, their own uses, their own limitations. Metallurgists try to make the best use of each one's talents, just as a track coach enters his fastest man in the 100-yard dash, his strongest in the shot or discus. It requires sound judgment, based on knowledge and experience, to do the best thing possible under the circumstances. No metal can be expected to stand up well under conditions too severe for it.

Materials and Standards

One phase of metallurgy at Baytown is to cooperate with other refinery groups in selecting materials and preparing standards for plant equipment. Materials are chosen to do the job properly and economically. If money were no object, it might be simplest to adopt a policy of "hang the cost; buy the best." But, if sound economics did not rule out that policy, experience would. Expensive alloys, strangely enough, do not always do the best job. In a large number of cases, a cheaper metal gives better performance. It is all a matter of tailoring each material to suit each job.

In discussing a proposed new unit for the refinery, it was developed that a certain vessel was needed to hold a material so corrosive it would eat through a 54-inch thickness of carbon steel in just one year. One type of stainless steel was suggested, but an unprotected shell of it 11 inches thick would last only one year, too. The solution, as it turned out, was to use a wall of common steel just strong enough to hold the pressure—but protected on the inside against corrosion with a layer of a special stainless steel.

Some metals endure tortures that would put a medieval inquisitor to shame. In the refinery's acid concentration plant, for example, water is removed from dilute sulphuric acid already used in operations. To "dry out" the acid, flue gas at a blistering 1000 degrees is introduced through pipes called "dip legs" that extend down into vats of the boiling acid. As the hot gas bubbles up through the dilute acid, it dehydrates the boiling mixture. It is difficult to imagine a service more severe than boiling acid outside a pipe and 1000 degrees gas inside! Yet, ways have been found to keep dip legs operating from six to 15 months between replacements.



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Metallurgists are responsible, too, for developing and testing welding and heat treatment procedures. Samples of welds are continually tested and examined to maintain workmanship, to keep units running economically, and to insure safety.

Heat Treatment

In heat treating, metals are subjected to an "ordeal by fire" to change their degree of hardness, increase their resistance to corrosion, and reduce stresses that may cause cracking. Methods of treatment include stress relieving, annealing, and tempering.

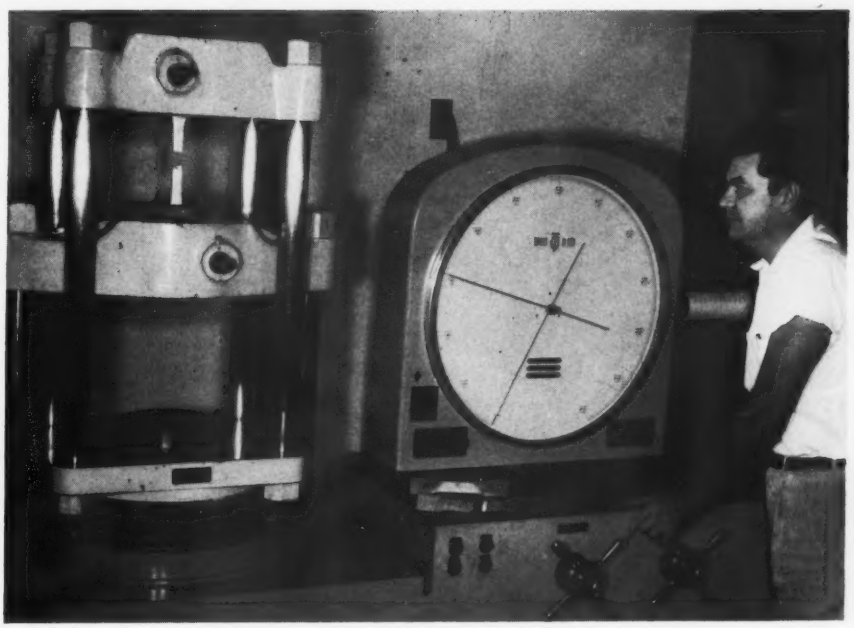
In *stress relieving,* metal is carefully heated up to a given point, held there for a definite period, then slowly cooled —all controlled according to a rigid prescription. This reduces crack-causing stresses within the metal and makes it easier to shape and bend without breaking. When two pieces are welded together and not stress-relieved, the weld contracts as it cools and sets up powerful forces which may crack the metal. The function of stress relieving is to distribute those forces evenly throughout the metal and reduce them to a lower level.

Annealing is heat treatment at a higher temperature than stress relieving. In this work, the metal structure itself is changed. The metal (weld and all) is rather homogenized, or made practically the same throughout its structure. Care must be taken to cool the metal even more slowly than in stress relieving, or it will become hard and brittle, more likely to crack than before treatment began.

Tempering, a form of heat treating metals as old as the blacksmith's art, toughens and hardens steel. Sword blades were tempered for knights of old by heating them to a cherry red glow, then quenching the blades suddenly by plunging them into cold water. Thus, an art that has remained essentially the same down through the ages now hardens and toughens Baytown hand tools used to strike with or be struck.

Quality Control

There are on record any number of dramatic, and often tragic, accidents caused by metal failure throughout the world. In the dead of winter, a Belgian bridge split with a sharp report and fell to the stream below. During a recent ten-year period, nearly a score of ships broke in two on the high seas, and had to be abandoned. In 1919, a huge storage tank burst near the Boston waterfront, drowning a dozen men and an undetermined number of horses in molasses!



Answering the question about how much a piece of metal can stand without breaking, this device pulls samples in two with ease. Unbroken piece, center, waits its turn.

Metallurgists and inspectors are forever vigilant against refinery failures. To keep equipment from breaking down before its allotted "three score and ten," they use instruments and devices that reveal the innermost secrets of metals. With some of these, they can literally "see through" a piece of steel. Others can be used for surface inspection only.

To inspect surfaces of non-magnetic metals, mainly stainless steels, a fluorescent penetrant is used. An oily dye, brushed on the metal, finds its way into tiny cracks too small for the eye to see. Excess dye is flushed off with water. Examined under "black light," the oil remaining in the cracks gives off a

Metallurgists at Baytown Refinery take pictures (called photomicrographs) of metal surfaces through a special camera-and-microscope that magnifies specimen 2100 times.

Measuring carbon content of metals includes heating a small porcelain boatful of metal shavings in a laboratory furnace.

Useful information about metal behavior is gained by placing small specimens right into operating equipment in the plant.

fluorescent glow, outlining the extent of the defects.

A magnetic-particle method of inspection is used for the surfaces of magnetic metals, such as carbon steel. First, an electric current is sent through the sample. Then a magnetic powder, dusted on the metal, collects on or above surface defects. Even troubles slightly below the surface can be detected with this method. It has been used to check compressor bearing caps, where failure and possible accident were prevented by replacing caps with incipient cracks. Hand tools and special pump bolts were examined with equally good results.

For a look at troubles lurking below the surface, metal specialists use X-rays. Metal walls up to three inches thick yield their secrets to the prying eyes of this machine, making it valuable for examining pipes and vessels. Films taken with X-rays often show that beauty in metals is only skin deep, that the inside is riddled with faults such as gas pockets, slag, voids, and shrinkage cracks. X-rays have also found flaws in blocks of expensive plastic, saving time that would have been consumed in machining those blocks into electrical insulators.

Another "seeing eye" pierces steel, but is not used to find flaws. This is a device that measures wall thickness electronically, rather than mechanically with calipers. Using it, metallurgists and metal inspectors can determine when a piece needs to be replaced. A one-milligram source of radium emits rays through the metal. A counter in the instrument shows the amount of radiation passing through the metal—an amount that increases as the wall wears thinner. In this way, close tabs can be kept on equipment, to replace it before it becomes dangerously thin.

Investigating Failures

With so much metal equipment in use around the clock at Baytown, failures do occur now and then. A collection of failures reposes in the metallurgy laboratory's "morgue." Careful studies conducted on each piece reveal the cause of the trouble. With this information, the course of work can be more intelligently guided to prevent similar failures or to guard more closely against them.

Some victims in the morgue yielded at last to pressure of gas or liquid. Some pieces lie hideously scarred and pitted from chemical corrosion. A few specimens blossomed outward in mushroom bursts; others folded inward, as if compressed by a giant hand. Bars and shafts await their post-mortems, as neatly sheared in two as cheese sliced by a sharp knife.

For a time, one of the most baffling to the metal sleuths of all failures in their "Black Museum" was a metal plate spotted with blister-like bumps. Some had burst, others rose in smoothly-rounded humps. Metallurgical studies eventually showed that an unusual force had been at work within the metal. While the plate was in service, atomic hydrogen had formed between particles in the metal structure. The atoms, diffusing through the particles, had changed to molecular hydrogen, sought out open spaces, and there exerted tremendous pressure. It was this pressure that had caused the blisters.

Another curious case was that of a huge vessel that had failed after long years of oil-and-catalyst service. The vessel wall had been fabricated of two layers of different metal, bonded together as the plate was rolled.

As the wall heated and cooled alternately during the refining process, the two metals expanded and contracted at different rates, building up stresses within themselves. To make matters worse, some of the particles in one layer reverted under high temperature to its elemental state, weakening the metal. Finally, the vessel gave up the tug-of-war within itself and cracked. The solution here was chiefly one of using carbon steel as a replacement material and

insulating it internally against high temperatures.

The camera helps specialists find flaws in metals just as readily as it helps criminologists detect faults that underlie human behavior. Metallurgists at Baytown take pictures of metal surfaces through a special camera-and-microscope that magnifies a specimen 2100 times. Most of these photomicrographs, as the pictures are called, resemble the surface of the moon seen through the great Palomar telescope, or an aerial shot of the Thames Estuary from 20,000 feet. Each grain of metal or other matter stands out, well defined, like a county on a state map. Cracks may wander about this "map" in snaky black lines, the width of the line showing the severity of the crack. Foreign matter or void space is delineated like a sore thumb. It would not be far wrong to call such a picture the "fingerprint" of a metal, for it reveals the individuality of the piece, setting it apart from all others.

Identifying Metals

Sometimes, Baytown metal experts are called upon to identify an unknown metal.

Spot tests are conducted chiefly with acids, caustics, and other chemicals. A sample can be put immediately in one of two broad metal groups simply by finding whether it is magnetic. Other tests identify the unknown by the process of elimination.

Carbon content of steel is important in deciding weldability. If the content is low, the piece can generally be welded satisfactorily; if carbon is high, welding may be advisable only when precautions are carefully observed.

Carbon content can be readily measured by heating a one-gram sample of metal shavings in a laboratory furnace and passing oxygen over the sample. Carbon dioxide, driven from the sample, is caught and absorbed in a caustic solution in a pear-shaped glass vessel, from which a reading on a burette scale gives the amount of carbon present.

Testing Materials

How much pressure can a piece of metal take? How much heat? Will it corrode quickly, slowly, or not at all? What does it look like inside? How hard is it? Will it bend without cracking? How far can it be stretched or drawn out?

These and other important questions can be answered after testing samples on machines in the metallurgy lab. One such device crushes metal samples with terrible forces ranging up to more than 120,000 pounds. Reversing its field, the device pulls pieces apart with as much ease and dispatch as a child dividing a double Popsicle.

By pressing a metal ball into the surface of a sample, and noting its penetration under a given force, metallurgists can tell how hard a sample is. Impact strength is determined by the number of foot pounds of energy absorbed before a specimen breaks under a trip-hammer blow.

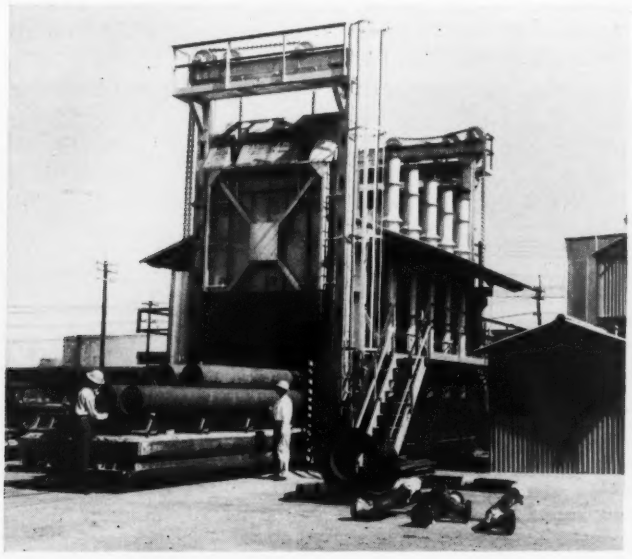
After it has been put through its paces in the laboratory, a piece of metal holds few secrets from its inquisitors. They know pretty well how it will perform in actual plant service. To supplement that knowledge, useful information about metal behavior is gained by placing small specimens cut to about the size of calling cards right into operating equipment in the refinery. A rack holding a dozen or more specimens can be welded into a pipe or vessel and kept there while the unit is "on stream," forcing it to endure the same operating conditions as its host. All specimens are weighed and checked carefully before they go in service and after they come out. This tells the specialist how much metal was lost and how the specimen behaved.

Economy and Safety

Metallurgists make no claim to carrying their work-load or shouldering their responsibilities alone. Their work with metals and metal behavior, they will tell you fairly and honestly, is in the nature of a joint venture—that they form only a part of the task force that is Baytown Refinery.

As one man put it, "We're all working on the same team, moving toward the same goal. It logically follows that we are trying to do what all groups at Baytown try to do—keep the refinery running as economically and as safely as possible."

In stress relieving, metal is carefully heated up to a given point, then carefully cooled to reduce crack-causing stresses.



Each piece in the "morgue" has been studied to find why it failed. This guards against similar failure in the future.

Power mower, equipped with a small gasoline engine, makes it easy for a boy to do what used to be a man-size job of lawn mowing; use of gasoline-powered mowers has increased phenomenally in recent years as a result of improvements in engines.

Power in Small Packages

Versatile little gasoline engines perform amazing variety of tasks to save time, labor, and money

PORTABLE gasoline engines—packing a tremendous wallop for their size—have now been adapted to power everything from grandpa's wood saw to junior's model airplane.

First cousin of the original outboard motors used on boats, these modern lightweight power units have turned up a whole new bag of labor-saving tricks. They provide the mechanical muscles for mowing and trimming lawns, cultivating gardens, sawing logs, digging fence post holes, and many other tiresome chores. They operate compressors for spraying paint or insecticides, and for refrigerating vegetable trucks. They furnish motive power for thousands of school boys who have turned from bicycles to motor scooters. And they have been adapted to countless uses in commercial and industrial plants.

Basically, today's portable gasoline engines are the same as those of 15 or 20 years ago. But in performance, they are far superior. They are smaller, lighter in weight, produce more power per pound of weight, and are much easier to start.

Most of this improved performance resulted from the development, just prior to World War II, of a more efficient magneto and better valve alloys. These technical advancements made it possible to build an engine that was able to hold a high spark at low speeds, to run smoothly, and to start easily after a long period of idleness. It could also be operated on regular leaded gasoline, available at any service station, instead of being limited to the hard-to-find white gasoline required for earlier models. And because the small engine could now use leaded gasoline, it was possible for the manufacturers to raise compression ratios and thereby increase the power output.

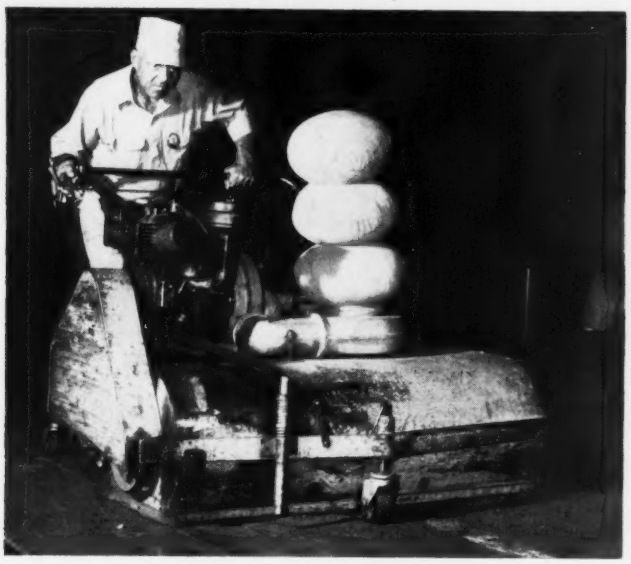
When the improved portable engines became available to the public after the War, their popularity skyrocketed. Americans are always eager to substitute petroleum power for muscle power to save time, energy, and money. The new portable engines made it possible to do this in numerous ways never before practical. Tremendous market demands for the powerful little engines enabled manufacturers to use the assembly line mass production method. This, in turn, enabled them to keep prices down, so more people could afford to buy them.

Now the throaty whir of the gasoline power lawnmower has become as familiar a weekend sound in residential areas as the rustle of the Sunday funny papers. Dependable, easy-starting outboard motors for boats have done more to stimulate interest in fishing than Isaac Walton. Farmers and ranchers have been quick to adopt the new power saws, post hole diggers, and other labor-saving devices made possible by the compact portable gasoline engine.

Mighty midgets of the petroleum age, these versatile little engines have won a secure place in modern American life.

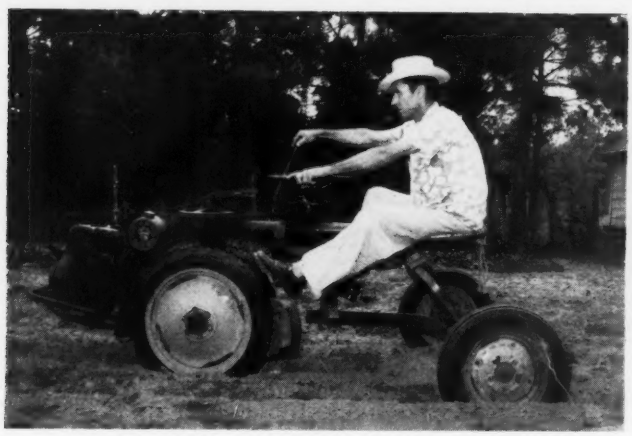
Chain saw, powered by a lightweight gasoline engine, saves time and labor in age-old chore of cutting logs and trees.

Tiny engine designed as high speed power unit for model airplane has single cylinder, operates with amazing efficiency.



King-size vacuum sweeper, powered by a small engine, simplifies task of keeping floors clean in large industrial plant.

Motor scooters serve many purposes, come in variety of models, from simple "put-puts" to elaborate machines like this.



Labor-saving garden tractors, made in many sizes and models, duplicate in miniature most operations of big farm tractors.

Powerful outboard motors have popularized the sport of boat racing; in less spectacular role, they propel fishing boats.

Fourteen Employees Retire

Two in latest group of annuitants served more than 32 years with Humble; eleven others have 25 or more years of service

FOURTEEN long-time employees have retired since the last report of retirements in these columns. Eleven of these annuitants have 25 or more years' service with the Company. Cary A. Talley and Warren J. Bennett have the longest service periods among these individuals, each having 32 years with Humble. Mr. Talley is a roustabout gangpusher at Hobbs, and Mr. Bennett is a chief gas tester at Baytown Refinery.

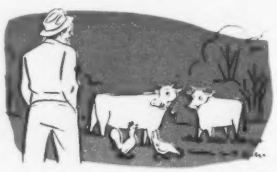
HUMBLE PIPE LINE COMPANY

A. D. WHEATON, assistant chief engineer at Longview Station, retired September 1 after more than 27 years' service. He was employed at Chilton as a laborer. His last ten years with the Company have been spent in Longview as assistant chief engineer. He likes to play golf as a recreation. He plans to build a home in Longview.

PRODUCTION DEPARTMENT

MARVIN H. BOW, employed at Healdton, Oklahoma, as a tool dresser, retired as a lease pumper-gauger August 30 after more than 31 years' service. Mr. Bow also worked in various capacities at Hewitt, Nocona, Kilgore, and Gladewater. He moved to Gladewater in 1933, where he worked until retiring.

Lease Pumper-Gauger JOHN W. BARNES at Wink retired October 12 after more than 25 years' service. He began work at Baytown Refinery as a laborer. He has also worked as a carpenter and roustabout. His special interests include raising chickens and shorthorn cattle. After retirement Mr. Barnes plans to do some editorial writing in his spare time for several magazines.



District Superintendent WALTER F. DEAN of Pampa retired September 30 with more than 34 years' service. Before becoming superintendent, Mr. Dean was a boom-time driller, having worked in such booming areas as Burkburnett from 1919 to 1920; in Wilson, Oklahoma, in the twenties; in Pampa from 1929 to 1930; and in Conroe from 1933 to 1934. Sports and traveling are included among his special interests. After retiring, he plans to travel for about a year and then settle in his new home in Pampa.

EMORY J. DODSON, roustabout gangpusher at Athens, retired September 28 after 28 years' service. Mr. Dodson joined the Company at Corsicana as a helper. Later he worked as a truck driver, roustabout, pumper, and gangpusher. He looks forward to trips to Hamilton Lake in Arkansas. "If the bass are not striking, I settle for perch," he says. At present he plans to spend a majority of his time fishing.

CLARENCE A. MOFF spent his career of nearly 29 years with Humble in the Stratton District. During the entire time, he lived in the same house. Mr. Moff started with the Com-

Employees Recently Returned from Military Service

AIR FORCE

NAME	LOCATION
Russell G. Barker	Baytown Refinery
Burras A. Batton, Jr.	Exploration-Geophysics, Florida
Kenneth McCoy Bowen, Jr.	Exploration-Geologic, North Texas
Douglas R. Butler	Baytown Refinery
James C. Ellis	Clear Lake Gas Plant
George E. Griffith	Baytown Refinery
Eugene L. Harshbarger, Jr.	Exploration-Geophysics, Texas
John F. Kasper, Jr.	Production, Corpus Christi
Jack R. Kitchen	Crude Oil Accounting, Houston
Y. M. Lannou	Baytown Refinery

ARMY

Brady A. Hand	Printing & Reproduction, Houston

NAVY

Hubert P. Bezner	Production, Tyler
Myra J. Dotson	Baytown Refinery
John P. Gajewski	Printing & Reproduction, Houston
Robert M. Hicks	Sales, Lubbock
John A. Reed, II	Production, Galveston Bay
William J. Russell, Jr.	Production, American Gas Plant
Owen E. Spruance, Jr.	Sales Technical Service, Houston
Robert J. Walker, Jr.	Titles and Records, Houston

pany as a fireman; he later served as the first pumper in the Seeligson area. He retired August 26 as a lease pumper-gauger. During retirement, he plans to catch up on his hunting and fishing. He hopes to purchase a trailer house and travel in the North during the summer and live in the South during the winter.

CARY A. TALLEY, roustabout gangpusher at Hobbs, retired August 14 after 32 years' service. Mr. Talley joined Humble as an engineer-pumper; he worked at Burkburnett, Olney, Holliday, Avoca, and Wasson, before going to Hobbs. His recreation includes hunting and fishing.

BAYTOWN REFINERY

Chief Gas Tester WARREN J. BENNETT retired August 30 after more than 32 years' service. He started as a welder in the Welding Department. Mr. Bennett became chief gas tester in February, 1940. His special interests include a greenhouse, garden, and cattle. He plans to move to a 173-acre ranch at Madisonville, Texas.

LUDWIG MAHLER, issue and inventory clerk, retired September 13. Mr. Mahler started with Humble in April 1926; he shortly thereafter resigned but returned to Humble in December of the same year. Mr. Mahler is a violinist in his spare time, and he considers music, gardening, and cooking his hobbies. He has 26 years' service with Humble.

STILLMAN PAUL H. MEARS in the Distillation Department retired September 1 with more than 29 years' service. Mr. Mears began work in the Pipe Department as a helper; he also worked in various capacities in Crude Stills. His special interests include farming, cattle raising, and fishing.

WALTER G. SEARS spent his entire career with Humble at the Refinery. He began in the Boilermaker Department; he ended his nearly 18 years' service August 15 as a helper in the Acid Plant. His hobbies are fishing and repairing electrical appliances, both of which he plans to pursue during retirement.

HOUSTON OFFICE

Following his retirement October 26, REEL A. BOYD, accountant in Refining Accounting, plans to enter some phase of the real estate business. Mr. Boyd retired with more than 30 years' service, all of which has been in Refining Accounting on various accounting jobs. At the beginning of World War II, he became head of a section on overcharges and loss and damage claims.

JAMES B. MCGEE, fuel oil salesman and first employee to devote full time to refinery and terminal fuel oil sales in both industrial and marine fields, retired October 10. Mr. McGee began in the Refining Department as lubricating oil salesman. He transferred to Fuel Oil Sales in November, 1930, and to Sales Department in May, 1947, to handle marine fuel oil sales to deep sea vessels. Mr. McGee has more than 23 years' service.

Employees Recently Called to Military Service

ARMY

NAME	LOCATION
Amon Andrus	Baytown Refinery
George W. Barclay, Jr.	Baytown Refinery
Hinson M. Barfield	Goose Creek, Production
Bobby D. Birmingham	Sales Accounting, Houston
Marvin E. Brown	Colorado District, Production
Robert Brown	Harbor Island Terminal, Pipe Line
Albert R. Gage	Maurbro District, Production
Julian U. Justiss	Conroe Production
Leon A. Konvicka	Katy Gas Cycling Plant
Paul Korbach	Baytown Refinery
Jan Kraayeveld	Treasury, Pipe Line
Carlos R. Lafayette	Conroe, Production
Thomas G. Lipscomb, II	Baytown Refinery
Kenneth Mills	Clear Lake Gas Plant
Carl N. Odom, Jr.	Exploration Geologic, Texas
Milton E. Perry	Lovell Lake, Production
Phil W. Phillips	Katy Gas Cycling Plant
Leonard R. Pringle	Louisiana Division Office, Prod.
Ivy J. Redmond, Jr.	Grand Isle, Production
Ivy R. Ringo	Conroe, Production
Richard H. Schuller	Traffic Bureau, Houston
James W. Thomas	Baytown Refinery
Leland R. Walding	Thompsons Production
Elmo S. Walker	Geophysics Research, Houston
George L. Webb	Katy Gas Cycling Plant
Clifford Westcott	Livingston Production
Glyn C. Willborg	Proration & Statistical, Pipe Line
Claude M. Yarbrough	Katy Gas Cycling Plant

AIR FORCE

Roy A. Bauer	Exploration Geologic, Louisiana
Charles F. Parr	Petroleum Engineering, Tyler
Jerry Prince	Printing & Reproduction, Houston
Ollin W. Williams, Jr.	Friendswood Production

MARINES

John B. Daly	Printing & Reproduction, Houston
James H. Grant	Printing & Reproduction, Houston

NAVY

Alfred W. Clarke, Jr.	Baytown Refinery
Calvin C. Griffin	P. L. Accounting, Houston
W. Pate	Exploration Geologic, Houston

DEATHS

Since the last issue of THE HUMBLE WAY, eight active employees and five annuitants have died.

Active employees who have died are: Charles Barnhill, 62, pipe fitter first at Baytown Refinery, on September 3; Bobby Joe Caylor, 25, rotary derrickman at Scott & Hopper District, on September 3; Leon D. Horn, 26, helper at Baytown Refinery on August 22; C. L. Hughes, 36, machine operator at Baytown Refinery on September 11; Johnnie D. Johnston, 50, gravity computer in Exploration-Geophysics in the Houston Office, on August 12; Marshall M. Moore, 54, gas plant engineer at Clear Lake Gas Plant, on September 8; LeRoy Parks, 52, laborer special at Baytown Refinery, on September 15; Leslie E. Rallins, painter second at Baytown Refinery, on October 3.

Annuitants: Arthur F. Boyd, 65, district clerk at Anahuac before his retirement, died on September 27; Frank H. Cuthbertson, 55, engineer at Tomball District before his retirement, died on August 21; Will Scott, 73, laborer at Baytown Refinery before his retirement, died September 3; Francis E. Waldrep, 63, insulator first at Baytown Refinery before his retirement, died on August 27; James E. Young, 77, engineer at Chilton Station before his retirement, died on September 22.

By the way . . .

HINES H. BAKER RECEIVES DISTINGUISHED SERVICE AWARD

E. A. Landreth Hines H. Baker R. H. Windfohr Amon G. Carter John R. Suman

Humble President Hines H. Baker this year received the Mid-Continent Oil and Gas Association's Distinguished Service Award, given annually to a representative of a major oil company for his contribution to the industry.

The presentation was made on October 7 at the Association's 34th annual convention, held this year in Houston. Ed A. Landreth, Fort Worth independent producer, presented the award to Mr. Baker.

A similar award for the outstanding independent oilman went to Amon G. Carter of Fort Worth, independent operator and publisher of the Fort Worth *Star Telegram*. John R. Suman, vice-president of Standard Oil Company (N.J.), made the presentation to Mr. Carter.

GAY CARROLL RETIRES, LUPER NAMED COMPTROLLER

Gay Carroll O. L. Luper

Gay Carroll, Humble comptroller since 1940, retired November 1. He was succeeded by O. L. Luper.

Mr. Carroll's retirement closed a period of more than 35 years with Humble. He started work in 1918 as a price clerk. In 1923 he was made assistant to the general accountant and in 1927, chief accountant. He was elected comptroller in September, 1940.

Mr. Luper is a native of Paden, Oklahoma, and was graduated from the University of Oklahoma. He joined the comptroller's department in 1946 and became assistant comptroller in December, 1952.

E. E. Hunter and W. J. Crawford were named assistant comptrollers.

HUMBLE EXHIBIT POPULAR AT STATE FAIR OF TEXAS

This year, as in the past, Humble's exhibit at the State Fair of Texas attracted many thousands who attended the Fair in Dallas on October 10-25.

The exhibit was completely remodeled for this year's Fair, featuring a mural painted by Belgian artist Jean VanNoten. Inside, thousands of visitors rested and relaxed to music and to continuous showings of the Football Highlights film.

THE COVER

The statue of La Salle on this issue's cover marks the spot where the great explorer landed in 1685. Carved in stone, his sword before him, La Salle overlooks the Gulf of Mexico near the site of Old Indianola, itself a historic landmark on the Texas coast.

The HUMBLE WAY

Vol. IX No. 3

SEPTEMBER-OCTOBER

1953

We Can See Underground..... 1

More Problems than Profits..... 6

The Magnificent Failure..... 9

Sketches by E. M. Schiwetz

Joutel's Notes on Texas.....15

Tons of Prevention.....16

Power in Small Packages.....20

Fourteen Employees Retire.....22

By the Way.....24

Published every other month for employees and stockholders

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P. O. Box 2180, Houston 1, Texas

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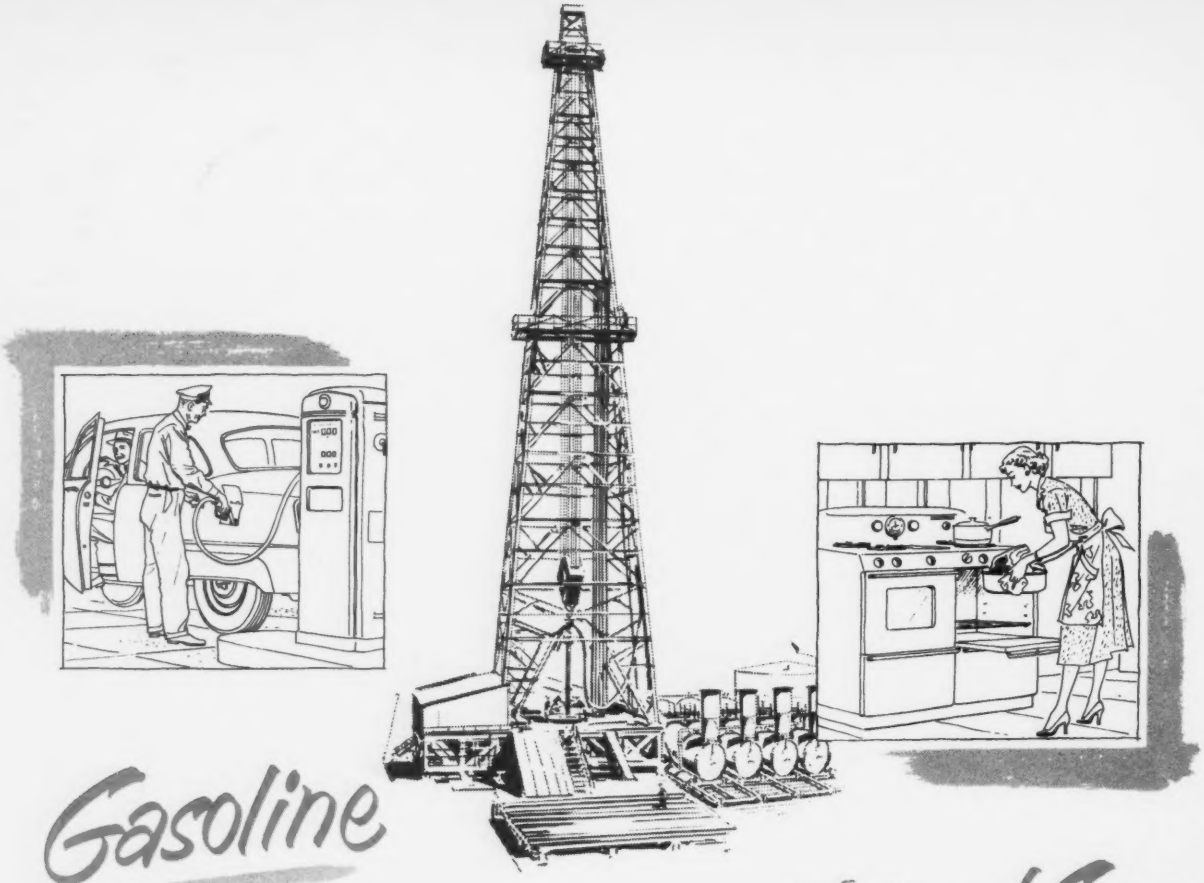
Art Credits: Front cover and pages 9, 10, 11, 12 and 14 by E. M. Schiwetz; page 15 by Bob Schoenke; all others by Harris Goode.

Not an aerial view of parched farmland, but a photomicrograph of a piece of metal that failed. Dark areas are cracks in the metal. See "Tons of Prevention," page 16.



Gasoline for Sunday driving... or Natural Gas to cook next Sunday's roast?

Most people think only of gasolines, lubricants, and fuel oils when the petroleum industry is mentioned. The fact is, practically all oil producers are also natural gas producers. So today the driller of a wildcat, or exploratory well, calls his venture successful if the well discovers either oil or gas.

If it is an oil well, then he has helped to supply the country's increasing needs for oil and oil products; if it is a gas well, he has discovered additional supplies of an efficient, economical fuel for household and industrial use.

Beginning with the location of the well, advanced geological and geophysical studies of underground formations aid in the selection of likely oil or gas producing areas, but still the odds against a wildcat well producing either gas or oil are eight to one.

If a natural gas field is discovered, reservoir engineers immediately begin their studies to determine the best producing methods to conserve the underground energy and to obtain the maximum production for the longest possible time.

If the gas that is discovered is "wet," it is processed in gasoline plants which remove the liquid parts and send them to refineries for further processing into motor fuels and aviation gasolines, or to petrochemical plants to be converted into a long list of useful chemical products, among which are the plastics and synthetic fabrics with which you are so familiar. "Dry" gas, the residue from gasoline plants, and sometimes produced direct from the gas field, is the natural gas that burns in literally millions of homes throughout America and under the boilers of thousands of American industries.

So, whether a wildcat well discovers oil for gasoline or natural gas for the kitchen stove, it adds to the available energy resources of the most highly mechanized nation on earth; it supplies products essential for today's and tomorrow's high living standards; it gives additional strength to measures for National defense.

HUMBLE OIL & REFINING CO.
HUMBLE PIPE LINE CO.